JC20 Rec'd PCT/PTO 08 MAR 2002

FORM PTO-1390 (REV 11-2000)	U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 36-1525
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		U.S APPLICATION NO (If known, see 37 C F R 1 5) 10/070618 Unknown
INTERNATIONAL APPLICATION NO. **PCT/GB00/03839**	INTERNATIONAL FILING DATE **5 October 2000**	PRIORITY DATE CLAIMED **8 October 1999**

TITLE OF INVENTION

CARTOON RECOGNITION

APPLICANT(S) FOR DO/EO/US

PAWLEWSKI

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The U.S. has been elected by the expiration of 19 months from the priority date (Article 31).
5. A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has **NOT** expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 To 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information. Amended Sheets (pages 9-12; claims 1-19)

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
Unknown 10/070618	PCT/GB00/03839	36-1525

21. ☒ The following fees are submitted:

	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):	
-- Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO $1040.00	
-- International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $890.00	
-- International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but international search fee (37 C.F.R. 1.445(a)(2)) paid to USPTO $740.00	
-- International preliminary examination fee (37 C.F.R. 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) $710.00	
-- International preliminary examination fee (37 C.F.R. 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890.00
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).	$ 0.00

CLAIMS	NUMBER FILED		NUMBER EXTRA	RATE		
Total Claims	17	-20 =	0	X	$18.00	$ 0.00
Independent Claims	2	-3 =	0	X	$84.00	0.00
MULTIPLE DEPENDENT CLAIMS(S) (if applicable)				$280.00		$ 0.00
				TOTAL OF ABOVE CALCULATIONS =		$ **890.00**
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.						0.00
				SUBTOTAL =		$ **890.00**
Processing fee of $130.00, for furnishing the English Translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(f)).				+		0.00
				TOTAL NATIONAL FEE =		$ **890.00**
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). **$40.00** per property				+		$ 40.00
Fee for Petition to Revive Unintentionally Abandoned Application ($1280.00 – Small Entity = $640.00)						$ 0.00
				TOTAL FEES ENCLOSED =		$ **930.00**
					Amount to be: refunded	$
					Charged	$

a. ☒ A check in the amount of $930.00 to cover the above fees is enclosed.
b. ☐ Please charge my Deposit Account No. 14-1140 in the amount of $_____ to cover the above fees. A duplicate copy of this form is enclosed.
c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 14-1140. A duplicate copy of this form is enclosed.
d. ☒ The entire content of the foreign application(s), referred to in this application is/are hereby incorporated by reference in this application.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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NAME

25,640 **March 8, 2002**
REGISTRATION NUMBER Date

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of

PAWLEWSKI Atty. Ref.: **36-1525**

Serial No. **Unknown** Group:

National Phase of: **PCT/GB00/03839**
International Filing Date: **5 October 2000**

Filed: **March 8, 2002** Examiner:

For: **CARTOON RECOGNITION**

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March 8, 2002

Assistant Commissioner for Patents
Washington, DC 20231

Sir:

PRELIMINARY AMENDMENT

Prior to calculation of the filing fee and in order to place the above identified application in better condition for examination, please amend as follows:

IN THE SPECIFICATION

Page 1, after the title insert the following:

-- This application is the US national phase of international application PCT/GB00/03839 filed October 5, 2000 which designated the U.S. --.

IN THE CLAIMS (AS ON AMENDED SHEETS)

Please substitute the following amended claims for corresponding claims previously presented. A copy of the amended claims showing current revisions is attached.

5. (Amended) A method according to claim 1, in which the step of analysing the dark pixel data includes dividing the image into blocks and identifying those blocks which contain a relatively small number of pixels identified by the ark pixel data.

6. (Amended) A method according to claim 2 in which:

the step of analysing the dark pixel data includes dividing the image into blocks and identifying those blocks which contain a relatively small number of pixels identified by the dark pixel data; and

the same block division is used both for the generation of dark pixel data and for the analysis.

7. (Amended) A method according to claim 5 in which the likelihood - representing signal is obtained by counting the identified blocks.

13. (Amended) An apparatus according to claim 9, in which the means for analysing the dark pixel data is operable (62, 63) to identify those blocks of a plurality of blocks into which the image is divided which contain a relatively small number of pixels identified by the dark pixel data.

14. (Amended) An apparatus according to claim 10 in which:

the means for analysing the dark pixel data is operable (62, 63) to identify those blocks of a plurality of blocks into which the image is divided which contain a relatively small number of pixels identified by the dark pixel data; and

the same block division is used both for the generation of dark pixel data and for the analysis.

15. (Amended) An apparatus according to claim 13 in which the likelihood-representing signal is obtained (63) by counting the identified blocks.

17. (Amended) A data carrier loadable into a computer and carrying instructions for causing the computer to carry out the method according to claim 1.

Cancel claims 18 and 19 without prejudice or disclaimer.

PAWLEWSKI
Serial No. **Unknown**

<u>REMARKS</u>

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "**<u>Version with markings to show changes made</u>**."

The above amendments are made to place the claims in a more traditional format.

Respectfully submitted,

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Serial No. **Unknown**

VERSION WITH MARKINGS TO SHOW CHANGES MADE

5. (Amended) A method according to claim 1, [2, 3 or 4,] in which the step of analysing the dark pixel data includes dividing the image into blocks and identifying those blocks which contain a relatively small number of pixels identified by the ark pixel data.

6. (Amended) A method according to claim [5 when dependent on claim 2, 3 or 4] 2 in which:

the step of analysing the dark pixel data includes dividing the image into blocks and identifying those blocks which contain a relatively small number of pixels identified by the dark pixel data; and

the same block division is used both for the generation of dark pixel data and for the analysis.

7. (Amended) A method according to claim 5 [or 6] in which the likelihood - representing signal is obtained by counting the identified blocks.

13. (Amended) [A] An apparatus according to claim 9, [10, 11 or 12,] in which the means for analysing the dark pixel data is operable (62, 63) to identify those blocks of a plurality of blocks into which the image is divided which contain a relatively small number of pixels identified by the dark pixel data.

14. (Amended) [A] An apparatus according to claim [13 when dependent on claim 10, 11 or 12] 10 in which:

the means for analysing the dark pixel data is operable (62, 63) to identify those blocks of a plurality of blocks into which the image is divided which contain a relatively small number of pixels identified by the dark pixel data; and

the same block division is used both for the generation of dark pixel data and for the analysis.

15. (Amended) [A] An apparatus according to claim 13 [or 14] in which the likelihood-representing signal is obtained (63) by counting the identified blocks.

17. (Amended) A data carrier loadable into a computer and carrying instructions for causing the computer to carry out the method according to [any one of claims 1 to 8] claim 1.

Cartoon Recognition

This invention relates to a method of and apparatus for determining whether an image, for example a frame of a video signal, represents a cartoon.

With the growing availability of online data, provision of hundreds or even thousands of data channels by an information provider causes problems of content management and verification, as manual checking of every piece of data becomes infeasible. For image data, there is increasing interest in techniques for automated image interpretation and classification. Automated image interpretation and classification could help with indexing, cataloging and searching of still image or moving image databases.

Image interpretation and classification can be done either by the service provider or by the service receiver. For example, if it is possible to determine whether a signal represents a cartoon or not then it is possible for parents to stop children from downloading pictures from the Internet or from watching TV programs other than cartoons. Other types of classifiers could prove useful, for example, classification of pornographic images or recognition of particular people.

According to the present invention there is provided a method for classifying whether an image represents a cartoon, comprising the step of generating a likelihood in dependence on the presence of low luminosity outlines in the image.

According to the present invention there is also provided a data carrier loadable into a computer and carrying instructions for causing the computer to carry out said method.

In a preferred embodiment the method further comprises the step of analysing the image to provide one or more parameters wherein one parameter relates to the luminosity of the image; and the generating step determines the generated likelihood in dependence upon the value of said one parameter.

Advantageously the image comprises a plurality of pixels and the analysing step includes the sub-step of vector quantising the image so that each pixel corresponds to one of a plurality of codes.

Preferably the analysing step further comprises the sub-step of calculating the percentage of pixels corresponding to a one of the plurality of codes and preferably said one of the plurality of codes is a code which corresponds to pixels of low luminosity.

In a preferred embodiment the vector quantising sub-step comprises sub-steps of dividing the image into a plurality of blocks, each block comprising a subset of pixels in the image; and independently vector quantising each block.

Advantageously the generating step comprises the sub-step of generating a block likelihood value for each of a plurality of blocks, the block likelihood representing the probability that the pixels in that block represent an image comprising one or more outlines and preferably the generating step comprises the sub-step of combining a plurality of block likelihood values to provide the likelihood value for the image.

According to another aspect of the present invention there is provided apparatus for classifying whether an image represents a cartoon said apparatus comprising generating means for generating a likelihood in dependence on the presence of low luminosity outlines in the image.

According to the present invention there is also provided a data carrier loadable into a computer and carrying instructions for enabling the computer to provide said apparatus.

In a preferred embodiment the apparatus further comprises means for analysing the image to provide one or more parameters wherein one parameter relates to the luminosity of the image; and the generating means receives in operation said one parameter and determines the generated likelihood in dependence upon the value of said one parameter.

Advantageously the analysing means comprises a vector quantiser which receives in operation a plurality of pixels comprising the image and outputs a plurality of codes each output code corresponding to each of the received pixels.

Preferably the analysing means further comprises means for calculating the percentage of pixels corresponding to a one of the plurality of codes and said one of the plurality of codes is a code which corresponds to pixels of low luminosity.

In a preferred embodiment the vector quantiser further comprises means for dividing the image into a plurality of blocks, each block comprising a subset of pixels in the image; and means for independently vector quantising each block.

Advantageously the generating means comprises means for generating a block likelihood value for each of a plurality of blocks, the block likelihood value representing the probability that the pixels in that block represent an image comprising one or more outlines and the generating means further comprises means for combining a plurality of block likelihood values to provide a likelihood value for the image.

An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which

Figure 1 is a schematic representation of a computer loaded with software embodying the present invention;
Figure 2 shows red, blue, green and luminance components for a cartoon;
Figure 3 shows red, blue, green and luminance components for a photograph;
Figure 4 shows red, blue, green and luminance components for a complex cartoon;
Figure 5 is a functional block diagram of the program elements that comprise the software indicated in Figure 1;
Figure 6 is a flow chart showing the method steps performed in one embodiment of the invention by the software illustrated in Figure 5;
Figure 7 is a flow chart showing the vector quantising step of the method illustrated in Figure 6;
Figure 8 is a flow chart showing the production of a low luminosity signal;
Figure 9 shows images for each level of vector quantisation for a cartoon and a photograph; and
Figure 10 is a flow chart showing the determination step of the method illustrated in Figure 6.

Figure 1 illustrates a conventional computer 101, such as a Personal Computer, generally referred to as a PC, running a conventional operating system 103, such as Windows (a Registered Trade Mark of Microsoft Corporation), and having a number of resident application programs 105 such as a word processing program, a network browser and e-mail program or a database management program. The computer 101 also includes an

image classification program 109 that enables a signal representing an image to be classified according to whether the image represents a cartoon. The computer 101 is also connected to a conventional disc storage unit 111 for storing data and programs, a keyboard 113 and mouse 115 for allowing user input and a printer 117 and display unit 119 for providing output from the computer 101. The computer 101 also has access to external networks (not shown) via a network card 121.

A simple image classification program for determining whether an image represents a cartoon can be implemented which analyses the colour distribution within the image. Figure 2a shows a cartoon (represented in a grey scale in the figure). Figure 2b is a histogram showing the number of pixels with particular values for the red component Figures 2c, 2d and 2e show similar histograms for the green, blue and luminance components. For this cartoon there are prominent spikes in each component. Figure 3 shows a similar set of histograms for an image which is not a cartoon. The distribution for each component shows no such spikes. However, for a more complicated cartoon, such as that shown in Figure 4, it is difficult to see any obvious distinction between the histograms of Figures 4b - 4e and those of Figures 3b - 3e.

As shown in Figure 6, in accordance with a method of the present invention at step 10 an input signal representing an image, for example a frame of video data, comprising a plurality of pixels is received. At step 20 the received signal is converted into a luminosity signal, which represents a grey scale version of the image, by calculating a luminosity value (L) for each pixel. The received signal has components representing a value in the range 0 to 255 for a red component (R) a blue component (B) and a green component (G) for each of the plurality of pixels which comprise the frame of video data. The luminosity value is calculated at step 20 using the equation

$$L = 0.299R + 0.587G + 0.114B$$

It is not necessary to use a calculated luminosity value; the invention works equally well if a vector comprising, for example, the R, G and B values is used. At step 30 the image represented by the luminosity signal is split into a plurality of block signals, each signal representing an area of the original image. In the embodiment of the invention described here, each block signal represents an area of the same size as the area represented by each other block signal (although the size may differ slightly due to quantisation effects) However, the areas represented by the block signals could equally well be different sizes from each other.

At step 40 each block signal is vector quantised into a predetermined number of levels. A code (for example an integer in the range 1 to the predetermined number of levels) being used to represent each level. At step 50 the vector quantised signals are used to provide a low luminosity signal comprising the vector quantised signals which represent the darkest level for each block. Finally at step 60 the lowest luminosity signal is used to determine whether the received signal represents a cartoon. It is not necessary to split the luminosity signal into a plurality of block signals prior to vector quantisation. However, the determination at step 60 is more accurate if the received signal is split into signals representing smaller blocks of the frame.

The algorithm now described with reference to Figure 7 is used to determine the level represented by each code and to assign each pixel value to a code. It is similar to the well known LBG algorithm (as described in Linde, Y, Buzo, A and Gray, R. M. "An algorithm for vector quantizer design", IEEE Trans. Comm., vol. COM-28, Jan 1980, S 84-86). In Figure 7 at step 42 each pixel value is assigned to a code. Initially there is a single code used to represent each pixel value. At step 43, for the or each code, the mean and the standard deviation of the pixel values which the or each code currently represents are calculated. The mean for the or each code is then associated with that code. At step 44, the code which represents pixel values having the greatest standard deviation is determined. A new value to be associated with that code is then calculated at step 45 as the mean for that code minus half the standard deviation for that code. If the new value is calculated to be less than zero then the new value is set to zero. At step 46 a new value to be associated with a new code is calculated as the mean plus half said standard deviation.

At step 47 one of the plurality of codes is assigned to each pixel value. A code is used to represent a pixel value if the value which that code is associated with is 'closer' to the pixel value than any of the other codes. In this embodiment of the invention, a luminosity value is used, so it is a simple matter to measure the distance between the luminosity value and the value associated with a code, by calculating the difference between the two values. In embodiments which use a vector of values to represent each pixel, such as R, G, and B values, a distance may be calculated using, for example, the 'city-block' distance or the least squares distance.

At step 48 a check is performed to check whether the number of codes corresponding to

the predetermined number of levels have been created. If not, the steps 43 to 47 are repeated. In the embodiment of the invention described here four codes are created for each block, although the number of codes (and hence the predetermined number of levels) does not need to be the same for each block. In embodiments of the invention using a vector of values for each pixel the vector quantising step operates in an analogous manner to that described above.

In Figure 8 at step 51 each block is taken in turn. At step 52 the luminance value for each pixel is set to be equal to the value associated with the code which is used to represent that pixel. At step 53 a signal is generated with the luminance value for each pixel set to white for each pixel which is not represented by the code associated with the lowest luminosity value for that block. In the embodiment of the invention described here a similar signal is generated (for display purposes) for each one of the codes, in order to generate images for each vector quantisation level. The image generated from the signals for the lowest luminosity value will be referred to as a level 0 image, the image generated from the signals for the next highest luminosity value will be referred to as a level 1 image, etc.

Figure 9 shows cartoon image 71 and photographic image 81, together with level 0 images 72 and 82, level 1 images 73, and 83, level 2 images 74 and 84, and level 3 images 75 and 85. It can be seen that the level 0 image 72 generated from the lowest luminosity signal for each block for the cartoon image 71 differs from the corresponding level 0 image 82 generated from a signal representing the photographic image 81. The level 0 image 72 clearly comprises a plurality of outlines whereas the level 0 image 82 does not. This is because even complex cartoons have outlines delineating the areas of one colour from the areas of another colour, even when the areas of colour are carefully shaded. Photographic images do not have such outlines. Small areas of the level 0 image 82 may be mistakenly judged to contain outlines, however the majority of the image 82 does not contain outlines.

At step 61 of Figure 10 the signal representing a frame of video data is separated into block signals representing smaller areas of the frame. These need not be the same size areas as were produced at step 30 of Figure 6. Again, each area represented by a signal need not necessarily be the same size as each other area represented by a signal. At step 62 the number of dark pixels for each block is determined. Then at step 63 the number of blocks which are likely to contain outlines is determined by testing whether the

percentage of dark pixels in a block less than a predetermined dark-threshold. At step 64 a test is performed as to whether the number of blocks which are likely to contain outlines divided by the total number of blocks is greater than a predetermined outline-threshold. If the calculated ratio is greater than the outline-threshold then the signal is deemed to represent a cartoon, otherwise the signal is deemed not to represent a cartoon. In the embodiment described, the test for whether a block contains outlines is fairly simple. It would be possible to replace steps 62 and 63 by a more sophisticated algorithm which detects, for example, narrow bands of dark pixels, or an algorithm for detecting substantially parallel edges where pixels change from dark to light, or vice versa, or to implement a classifier using a neural network.

As shown in Figure 5 an image classification program 109 according to the invention comprises a grey scale converter 130 which performs steps 10 and 20 of Figure 6, an analysing means 140 which performs steps 30, 40 and 50 of Figure 6, and a likelihood generator 150 which performs step 60 of Figure 6. The analysing means 140 comprises a vector quantiser 142 which performs steps 30 and 40 of Figure 6 and a luminosity parameter generator 144 which performs step 50 of Figure 6. The likelihood generator 150 comprises a low luminosity block signal generator 152, a block likelihood generator 154 and a likelihood combiner 156. The vector quantiser 142 comprises a block signal generator 146 and a block signal vector quantiser 148. The luminosity parameter generator 144 comprises a low luminosity signal generator 132 and a percentage of low luminosity signals calculator 134.

As will be understood by those skilled in the art, the image classification program 109 can be contained on various transmission and/or storage mediums such as a floppy disc, CD-ROM, or magnetic tape so that the program can be loaded onto one or more general purpose computers or could be downloaded over a computer network using a suitable transmission medium.

Whilst the invention has been described with reference to a signal representing an image comprising a plurality of pixels, it will be appreciated that the detection of low luminosity outlines may equally well be performed on images for which the original source of the image does not represent the image as a plurality of pixels.

Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise", "comprising" and the like are to be construed in an inclusive as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to".

CLAIMS

1. A method of determining whether an image is a cartoon, comprising

(a) receiving values for respective picture elements of the image;

(b) generating dark pixel data identifying picture elements of the image having a low luminance relative to other picture elements thereof;

(c) analysing only the dark pixel data to generate a signal indicating the likelihood that the image is a cartoon.

2. A method according to claim 1 in which the step of generating the dark pixel data comprises dividing the image into blocks, and identifying those picture elements having, in accordance with a predetermined criterion, a lower luminance than the other elements within that block.

3. A method according to claim 2 in which the step of generating the dark pixel data includes assigning to a block a plurality of representative levels in accordance with the statistics of the values for the picture elements of the respective block, and identifying as lower luminance picture elements those elements whose values are nearest to the darkest one of the representative levels assigned to the block in which it occurs.

4. A method according to claim 3 in which the step of assigning a plurality of representative levels comprises an iterative process of choosing that one of the representative levels in respect of which the standard deviation of the values of the picture elements that are closest to it is largest, and replacing that level with two representative levels.

5. A method according to claim 1, 2, 3 or 4, in which the step of analysing the dark pixel data includes dividing the image into blocks and identifying those blocks which contain a relatively small number of pixels identified by the dark pixel data.

6. A method according to claim 5 when dependent on claim 2, 3 or 4 in which the same block division is used both for the generation of dark pixel data and for the analysis.

7. A method according to claim 5 or 6 in which the likelihood-representing signal is obtained by counting the identified blocks.

8. A method according to claim 7 including the further step of comparing the likelihood-representing signal with a threshold to produce a signal to indicate that the image is or is not a cartoon.

9. A apparatus for determining whether an image is a cartoon, comprising means (10) for receiving values for respective picture elements of the image and (50) generating dark pixel data identifying picture elements having a low luminance relative to other picture elements; and means (60) operable to analyse only the dark pixel data to generate a signal indicating the likelihood that the image is a cartoon.

10. A apparatus according to claim 9 in which the means for generating the dark pixel data is operable (30) to divide the image into blocks, and (40, 50) to identify those picture elements having, in accordance with a predetermined criterion, a lower luminance than the other elements within that block.

11. A apparatus according to claim 10 in which the means for generating the dark pixel data is operable (40) to assign to a block a plurality of representative levels in accordance with the statistics of the values for the picture elements of the

respective block, and (50) to identify as lower luminance picture elements those elements whose values are nearest to the darkest one of said representative levels.

12. A apparatus according to claim 11 in which the means for generating the dark pixel data is operable to assign the plurality of representative levels by an iterative process of choosing that one of the representative levels in respect of which the standard deviation of the values of the picture elements that are closest to it is largest, and replacing that level with two representative levels.

13. A apparatus according to claim 9, 10, 11 or 12, in which the means for analysing the dark pixel data is operable (62, 63) to identify those blocks of a plurality of blocks into which the image is divided which contain a relatively small number of pixels identified by the dark pixel data.

14. A apparatus according to claim 13 when dependent on claim 10, 11 or 12 in which the same block division is used both for the generation of dark pixel data and for the analysis.

15. A apparatus according to claim 13 or 14 in which the likelihood-representing signal is obtained (63) by counting the identified blocks.

16. A apparatus according to claim 15 including means (64)for comparing the likelihood-representing signal with a threshold to produce a signal to indicate that the image is or is not a cartoon.

17. A data carrier loadable into a computer and carrying instructions for causing the computer to carry out the method according to any one of claims 1 to 8.

18. A method for classifying whether an image represents a cartoon substantially as described herein with reference to the accompanying drawings.

19. An apparatus for classifying whether an image represents a cartoon substantially as described herein with reference to the accompanying drawings.

ABSTRACT

Cartoon Recognition

A method of analysing an image for example from a video signal for the presence of outlines to determine whether the image is likely to represent a cartoon is based on the concept that cartoons are often characterised by the presence of dark outlines around objects. In an improved version the signal is separated into signals representing smaller areas of the image before analysing each signal for the presence of dark outlines.

Figure 6

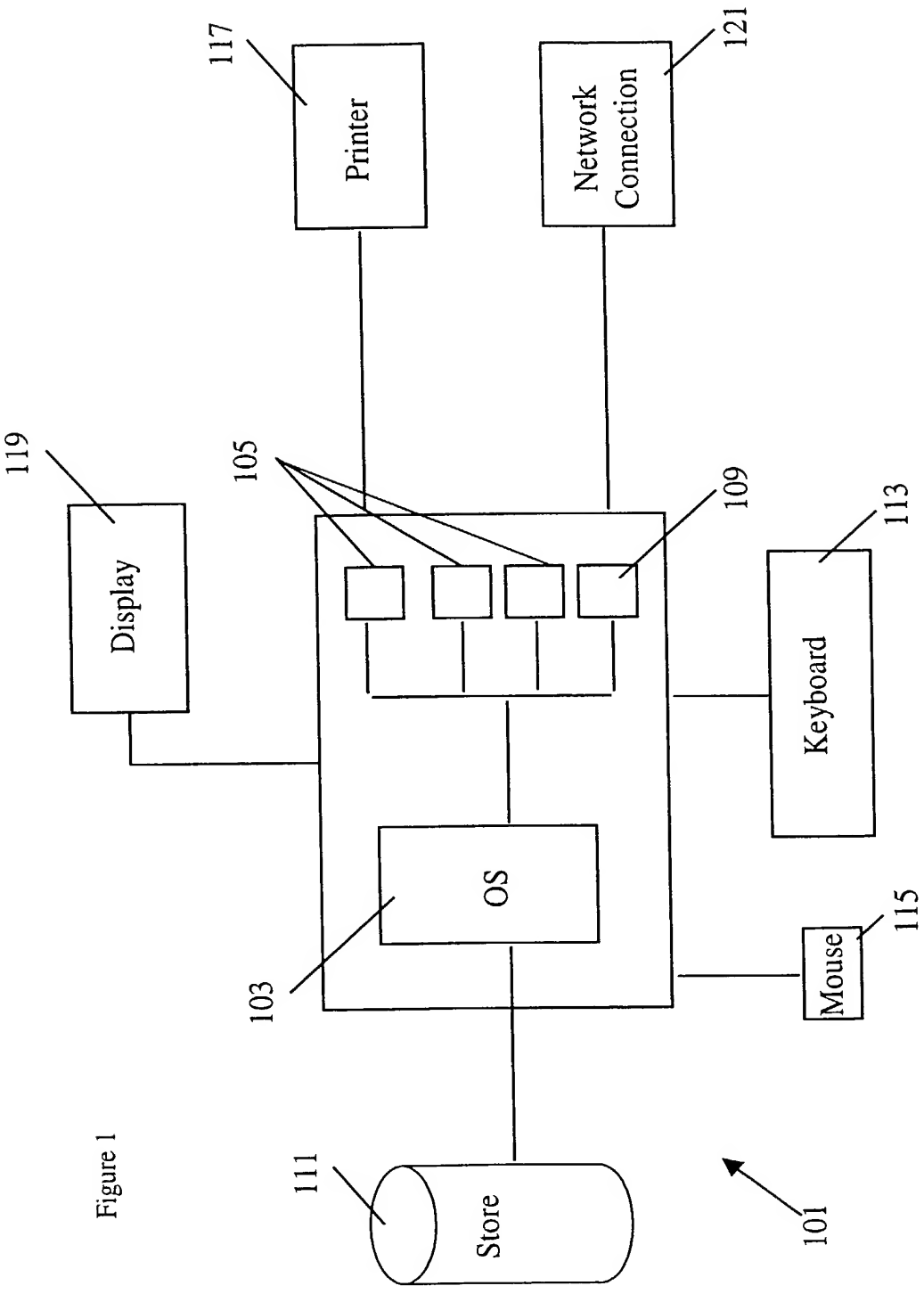

117
Printer
121
Network Connection
119
Display
105
109
113
Keyboard
OS
103
115
Mouse
111
Store
101

Figure 1

Figure 2a

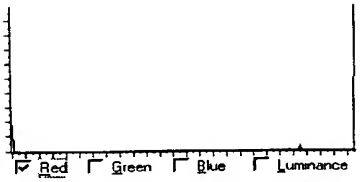


Figure 2b

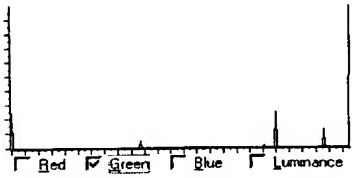


Figure 2c

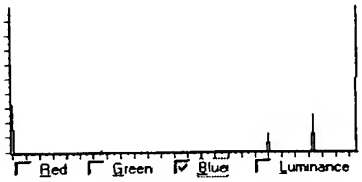


Figure 2d

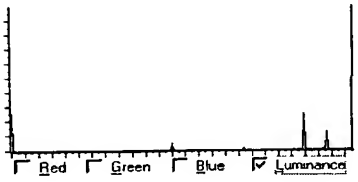


Figure 2e

Figure 2

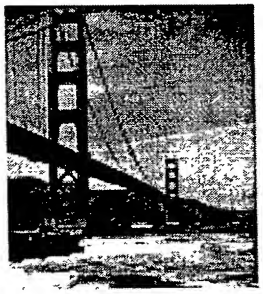


Figure 3a

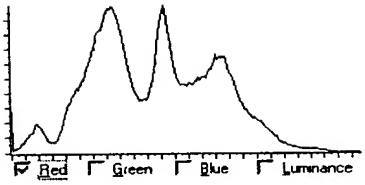


Figure 3b

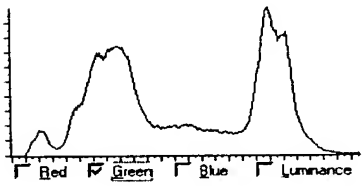


Figure 3c

Figure 3

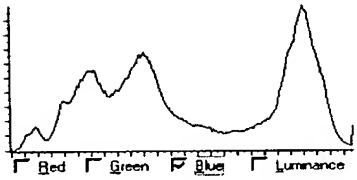


Figure 3d

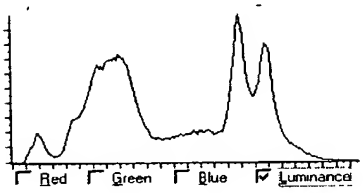


Figure 3e

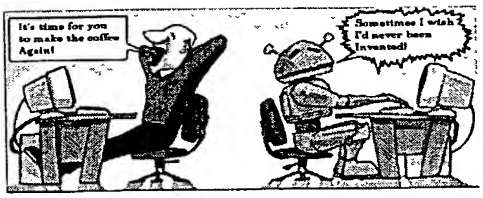


Figure 4a

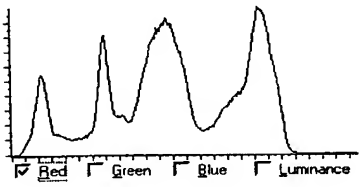


Figure 4b

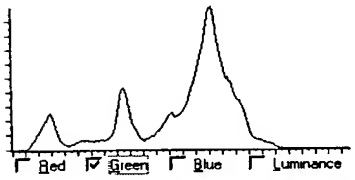


Figure 4c

Figure 4

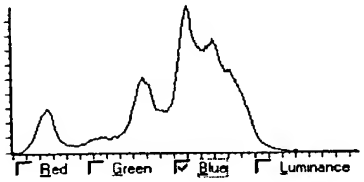


Figure 4d

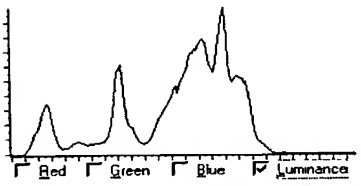


Figure 4e

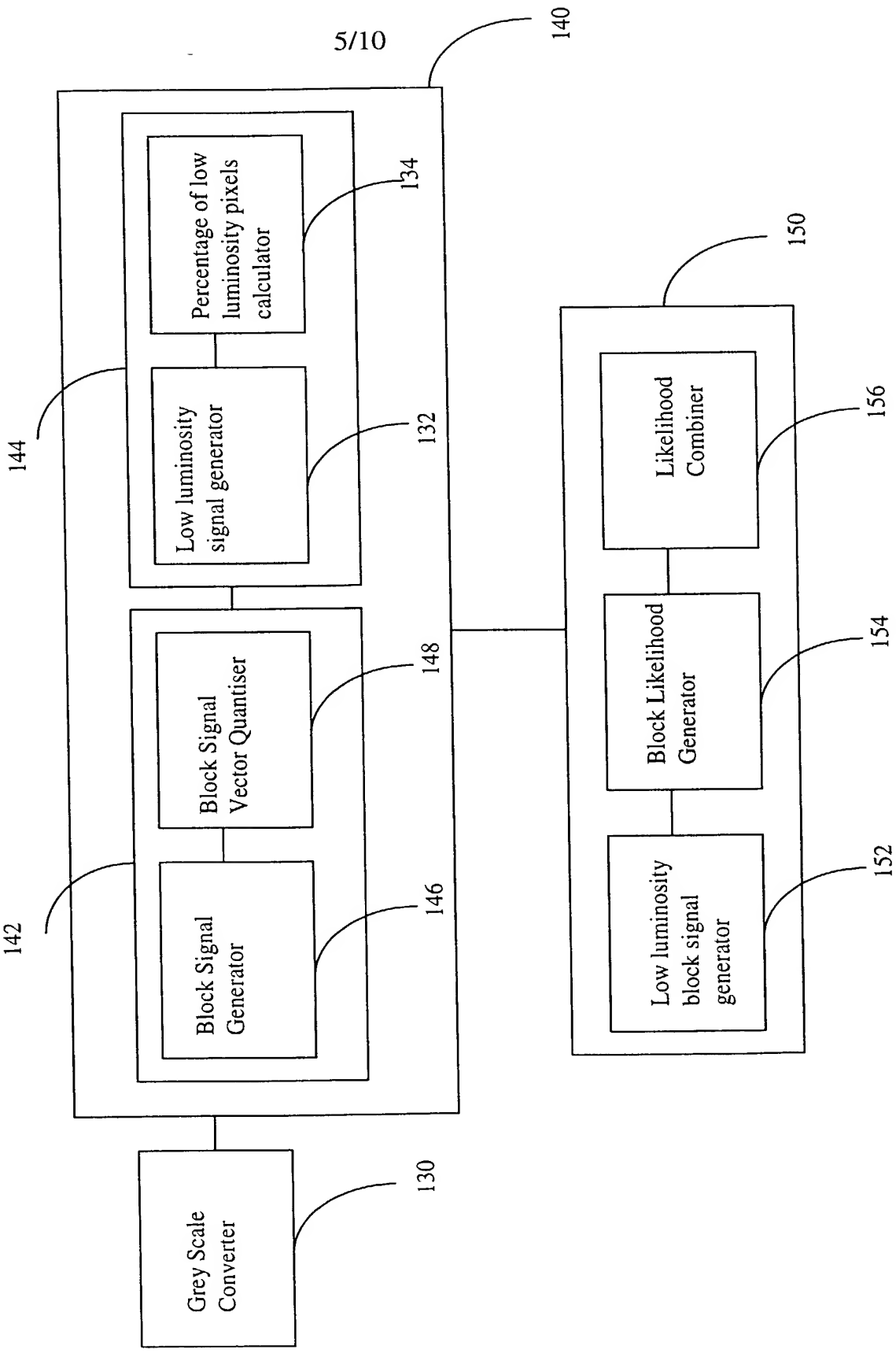

Grey Scale Converter
130
140
142
Block Signal Generator
146
Block Signal Vector Quantiser
148
144
Low luminosity signal generator
132
Percentage of low luminosity pixels calculator
134
150
Low luminosity block signal generator
152
Block Likelihood Generator
154
Likelihood Combiner
156

Figure 5

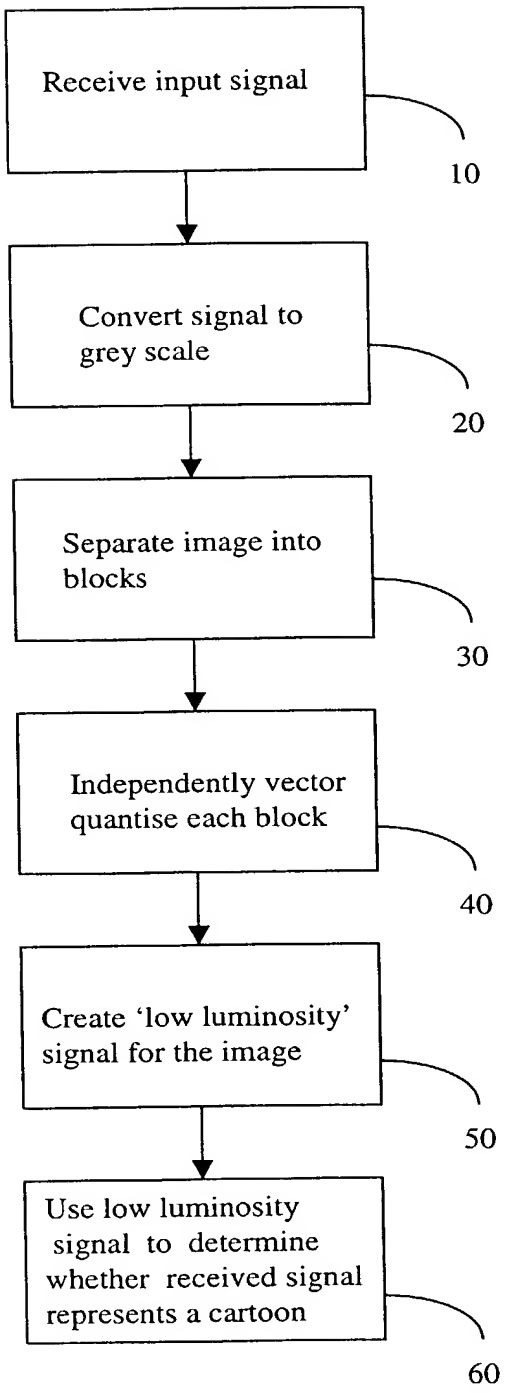

Receive input signal
10
Convert signal to grey scale
20
Separate image into blocks
30
Independently vector quantise each block
40
Create 'low luminosity' signal for the image
50
Use low luminosity signal to determine whether received signal represents a cartoon
60

Figure 6

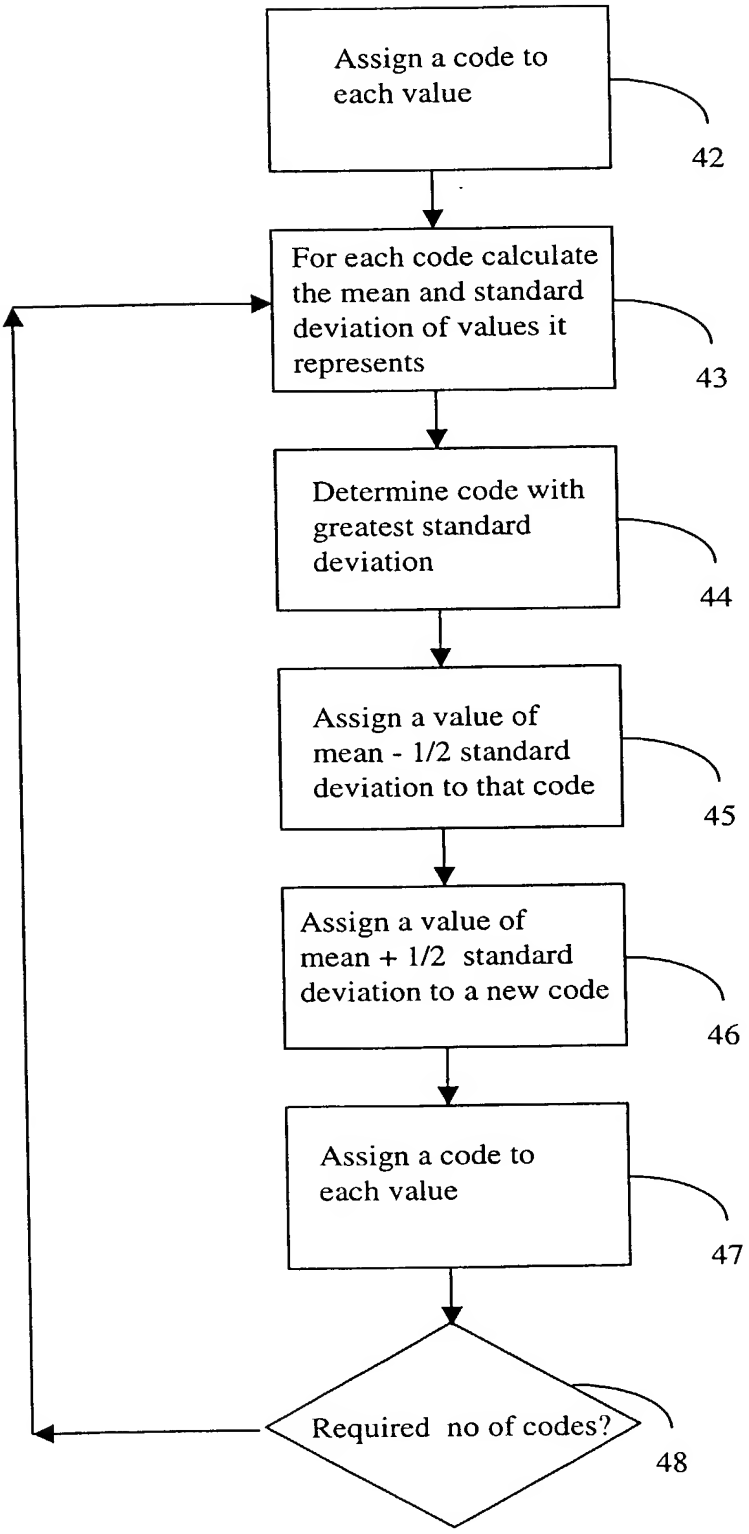

Assign a code to each value
42
For each code calculate the mean and standard deviation of values it represents
43
Determine code with greatest standard deviation
44
Assign a value of mean - 1/2 standard deviation to that code
45
Assign a value of mean + 1/2 standard deviation to a new code
46
Assign a code to each value
47
Required no of codes?
48

Figure 7

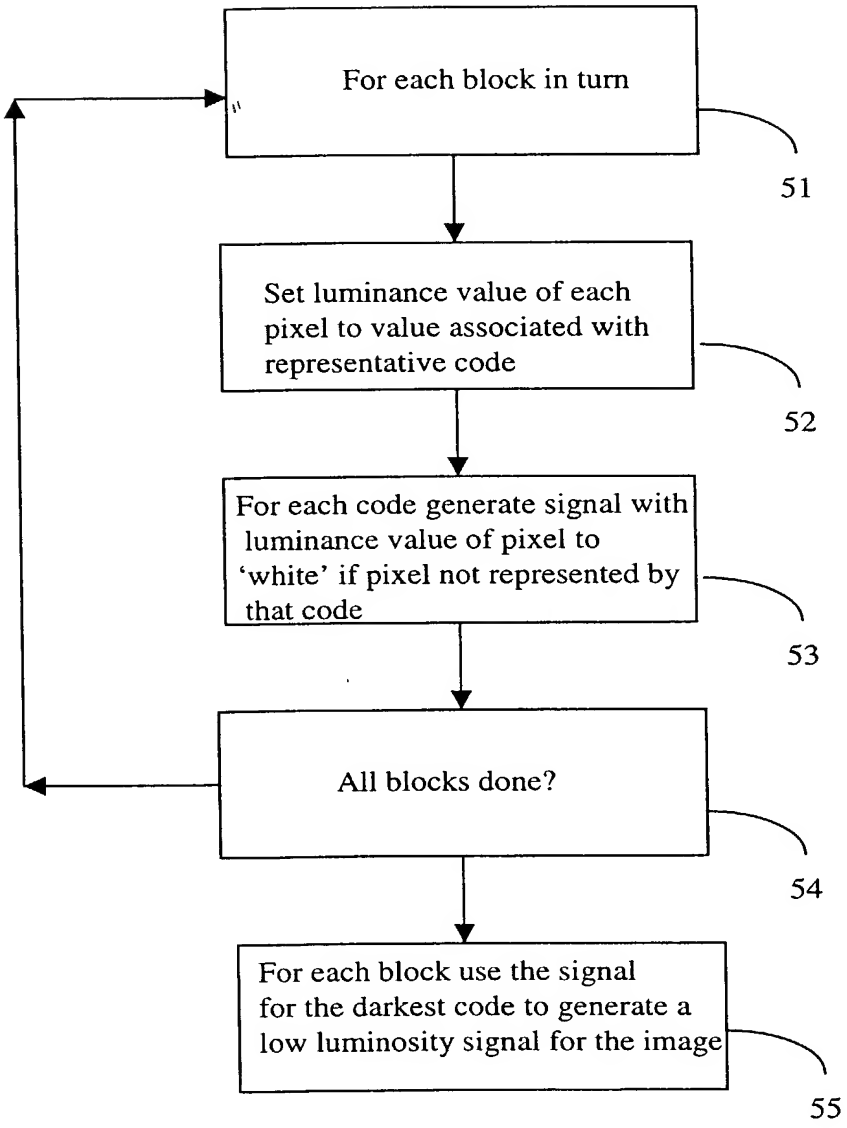
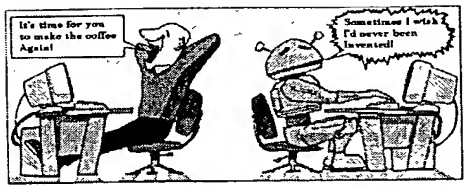
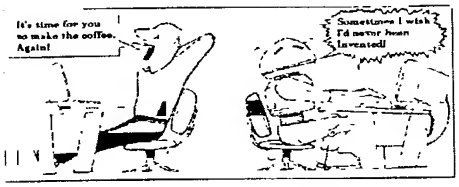

For each block in turn
51
Set luminance value of each pixel to value associated with representative code
52
For each code generate signal with luminance value of pixel to 'white' if pixel not represented by that code
53
All blocks done?
54
For each block use the signal for the darkest code to generate a low luminosity signal for the image
55

Figure 8



71

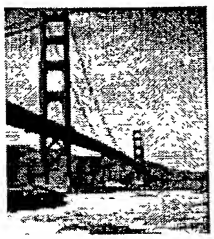


72

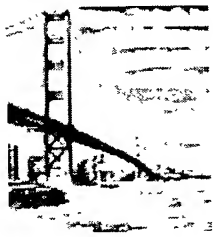
73

74

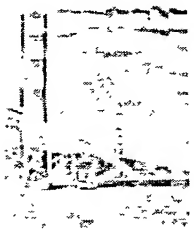
75



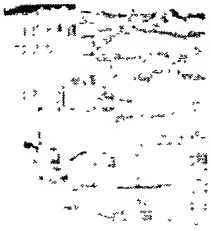
81



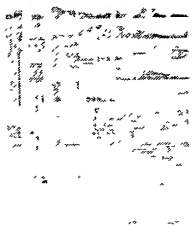
82



83



84



85

Figure 9

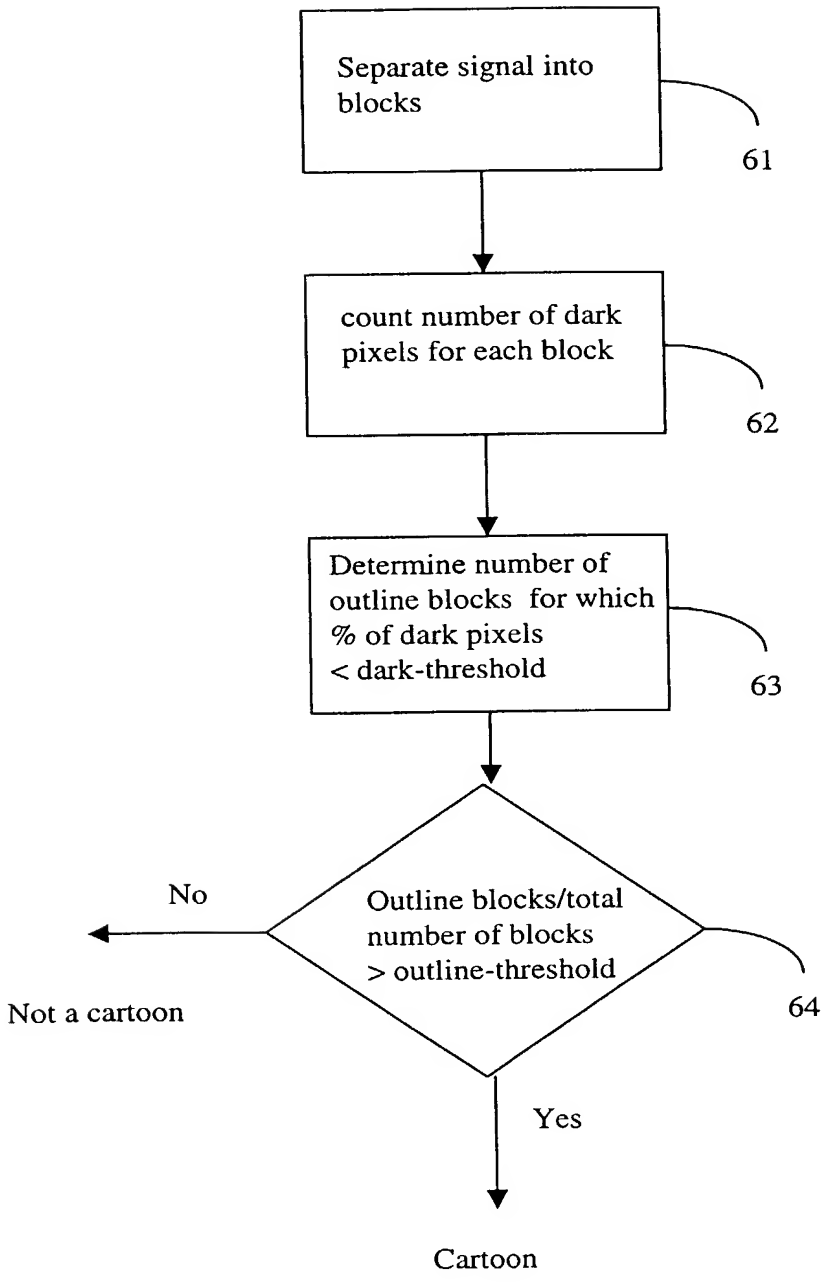

Separate signal into blocks
61
count number of dark pixels for each block
62
Determine number of outline blocks for which % of dark pixels < dark-threshold
63
Outline blocks/total number of blocks > outline-threshold
64
No
Not a cartoon
Yes
Cartoon

Figure 10

Nixon & Vanderhye P.C. (10/99)
(Domestic Non-Assigned/Foreign)

RULE 63 (37 C.F.R. 1.63)
DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:
CARTOON RECOGNITION

the specification of which (**check** applicable **box(s)**):
☐ is attached hereto
☐ was filed on _____ as U.S. Application Serial No. _____ (Atty Dkt. No. _____)
☒ was filed as PCT International application No. **PCT/GB 00/03839** on **05 October 2000**
and (if applicable to U.S. or PCT application) was amended on _____

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the patentability of this application in accordance with 37 C.F.R. 1.56. I hereby claim foreign priority benefits under 35 U.S.C. 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed or, if no priority is claimed, before the filing date of this application:
Priority Foreign Application(s):

Application Number	**Country**	**Day/Month/Year Filed**
99307971.4	**EUROPE**	**8 October 1999**

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below.

Application Number	**Date/Month/Year Filed**

I hereby claim the benefit under 35 U.S.C. 120/365 of all prior United States and PCT international applications listed above or below and, insofar as the subject matter of each of the claims of this application is not disclosed in such prior applications in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. 1.56 which occurred between the filing date of the prior applications and the national or PCT international filing date of this application:

Prior U.S./PCT Application(s): Application Serial No.	**Day/Month/Year Filed**	**Status: patented pending, abandoned**
PCT/GB00/03839	05 October 2000	**PENDING**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon. And on behalf of the owner(s) hereof, I hereby appoint **NIXON & VANDERHYE P.C., 1100 North Glebe Rd., 8th Floor, Arlington, VA 22201-4714, telephone number (703) 816-4000 (to whom all communications are to be directed)**, and the following attorneys thereof (of the same address) individually and collectively owner's/owners' attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent: Arthur R. Crawford, 25327; Larry S. Nixon, 25640; Robert A. Vanderhye, 27076; James T. Hosmer, 30184; Robert W. Faris, 31352; Richard G. Besha, 22770; Mark E. Nusbaum, 32348; Michael J. Keenan, 32106; Bryan H. Davidson, 30251; Stanley C. Spooner, 27393; Leonard C. Mitchard, 29009; Duane M. Byers, 33363; Jeffry H. Nelson, 30481; John R. Lastova, 33149; H. Warren Burnam, Jr. 29366; Thomas E. Byrne, 32205; Mary J. Wilson, 32955; J. Scott Davidson, 33489; Alan M. Kagen, 36178; Robert A. Molan, 29834; B. J. Sadoff, 36663; James D. Berquist, 34776; Updeep S. Gill, 37334; Michael J. Shea, 34725; Donald L. Jackson, 41090; Michelle N. Lester, 32331; Frank P. Presta, 19828; Joseph S. Presta, 35329 I also authorize Nixon & Vanderhye to delete any attorney names/numbers no longer with the firm and to act and rely solely on instructions directly communicated from the person, assignee, attorney, firm, or other organization sending instructions to Nixon & Vanderhye on behalf of the owner(s).

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1-06

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2. Inventor's Signature: _____ Date: _____
Inventor: (first) MI (last) (citizenship)
Residence: (city) _____ (state/country) _____
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(Zip Code) _____

FOR ADDITIONAL INVENTORS, check box ☐ and attach sheet with same information and signature and date for each.